

Comparison of Variability in Attainable Travel Distance and Human Performance Between 2 Types of Self-Contained Self-Rescuer Respirators

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Project Goal

This investigation will characterize the variability in travel distance and human metabolic performance while using NIOSH-approved SCSR respirators.

Stakeholders

- Respirator manufacturers
- Miners & Coal Mine Industry
- UMWA
- ISO
- MSHA
- NMA

Background

- The self-contained self-rescuer (SCSR) respirator is the only respiratory protection available during a mine escape. The SCSR is an escape-only closed-circuit self-contained breathing apparatus designed to provide respiratory protection from atmospheric contaminants immediately dangerous to life or health. Its self-contained characteristics allow respiratory gases in the exhaled breath to be conditioned during inhalation, that is, the respirator removes (scrubs) the CO₂ from exhalation and supplements unused O₂. There are currently two types of O₂ supplementation (chemical reaction and compressed gas) and one form of CO₂ removal (chemical reaction).
- Previous research has provided information on the various metabolic performance characteristics from using SCSR respirators. Using an automated breathing and metabolic simulator, SCSR performance variance occurred within duration time, breathing gas concentrations, breathing temperatures and breathing pressures among four NIOSH-approved one-hour SCSR models. In a recent investigation using human subjects, human performance (travel distance) widely varied among both men and women using the same SCSR model.

Methods

- Respirators selected include models of chemical reaction oxygen generators: Oxy K Plus by Dräger and SR-100 by CSE. The models using compressed O₂ are the EBA 6.5 and M-20, both manufactured by Ocenco. The SCSR respirators are approved for 60 minutes of use, except the Ocenco M-20 which is approved for 10 minutes of use. The dockable-hybrid SCSR (TPI) will be included pending NIOSH-approval.
- All tests will be conducted using current miners wearing typical clothing, boots, and simulated weight characteristics from the required personal protection and gear (e.g., cap lamp & battery) used in mining.
- Testing will be conducted on a motorized treadmill until fatigued, oxygen supply is exhausted, insufficient CO₂ removal, F_IO₂ < 19.5%, or F_ICO₂ > 4%.



Dräger Oxy K Plus



Ocenco EBA 6.5

Disclaimer: The findings and conclusions in this poster have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.



Ocenco M-20

Data Analyses

- Respirator performance:
 - Minimum and average inhaled O₂ and CO₂ concentrations
 - Inhalation and exhalation pressures
 - Inhalation and exhalation temperatures
- Human performance :
 - Distance traveled (total miles, total kilometers, and speed)
 - O₂ consumption and CO₂ production (milliliters·kilogram⁻¹·minute⁻¹, milliliters·minute⁻¹, liters·meter⁻¹, and total liters)
 - Duration (minutes)



CSE SR-100

Timeline

Project Goal	Expected Completion
Procure SCSR respirators	FY2009
Develop experimental design	FY2010
Network with UMWA and coal company for subject recruitment	FY 2010
Data collection	FY2011
Scientific presentation	FY2011
Scientific manuscript	FY2012

References

- Turner, N., E. Sinkule, and S. Hota (2002). Performance of Self-Contained Self-Rescuers During a Man Test 4 Protocol for the Automated Breathing and Metabolic Simulator. Presented at the American Industrial Hygiene Conference and Exposition, San Diego, CA.
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